CLAIMS

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A plug for controlling fluid flow in a well bore, the 1. 3 plug comprising a substantially cylindrical body 4 adapted for location on a work string, the body . 5 including a bore through a portion thereof and one or 6 more radial ports for passage of fluid from the bore 7 to an outer surface of the body, an actuating member 8 moveable relative to the body so as to cover the one 9 or more radial ports in a first position and uncover 10 the one or more radial ports in a second position 11 wherein movement of the actuating member is 12 controlled by an actuating mechanism, the mechanism 13 being operable under pressure in the well bore to set 14 the plug in a first natural state wherein the 15 actuating member is in the first position for a 16 pressure under a predetermined pressure range; a 17 second closed state wherein the actuating member is 18 locked in the first position regardless of the 19 pressure; and a third open state wherein the 20 actuating member is moved to the second position on 21 increasing the pressure to the predetermined pressure 22 range and holding the pressure in the range for a 23 predetermined time. 24

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26 2. A plug as claimed in Claim 1 wherein the actuating
27 mechanism comprises one or more pistons operated on
28 by the applied pressure.

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30 3. A plug as claimed in Claim 2 wherein the actuating
31 mechanism comprises first and second pistons; the
32 first piston including a damping element for delaying
33 movement of the first piston relative to the second

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piston under the applied pressure; the second piston 1 acting on a retaining element; the retaining element 2 adapted to hold the second piston in an intermediate . . 3 position when the applied pressure is within the predetermined range and allow movement of the first 5 piston to a final position; the retaining element 6 allowing the second piston to move to a secondary 7 position when the applied pressure is above the 8 predetermined range; a locking element which prevents 9 movement of the first piston when the second piston 10 is in the secondary position; and a securing element 11 for retaining the actuating member in the first 12 position until released by virtue of the first piston 13 reaching the final position, whereby the actuating 14 member moves to the second position and opens the 15 16 plug.

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18 4. A plug as claimed in Claim 3 wherein the damping element is a fluid metering device.

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21 5. A plug as claimed in Claim 3 or Claim 4 wherein the retaining element is a collet.

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24 6. A plug as claimed in Claim 5 wherein the locking
25 element is a sleeve such that the retaining element
26 and the locking element engage to control movement of
27 the pistons.

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7. A plug as claimed in Claim 1 wherein the actuating
mechanism may comprises a pressure sensor located in
the bore to measure the applied pressure, a processor
programmed to control a motor in response to the
pressure wherein operation of the motor causes the

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required relative movement between the actuating member and the body.

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4 8. A plug as claimed in Claim 7 wherein the mechanism
5 also comprises a securing element for retaining the
6 actuating member in the first position.

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9. A plug as claimed in any preceding Claim wherein theactuating member is a sleeve.

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11 10. A plug as claimed in Claim 9 wherein the securing
12 element is one or more locking keys which engage with
13 the sleeve.

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15 11. A plug as claimed in any preceding Claim wherein the 16 predetermined range for the pressure is approximately 17 1200 to 1800 psi.

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19 12. An actuating mechanism for operating a tool used in a 20 well bore, the mechanism comprising first and second 21 pistons; the first piston including a damping element for delaying movement of the first piston relative to . 22 23 the second piston under an applied pressure; the second piston acting on a retaining element; the 24 . retaining element adapted to hold the second piston 25 in an intermediate position when the applied pressure 26 is within a predetermined range and allow movement of 27 28 the first piston to a final position; the retaining 29 element allowing the second piston to move to a secondary position when the applied pressure is above 30 the predetermined range; a locking element which 31 prevents movement of the first piston when the second 32

piston is in the secondary position; an actuating

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1		member whose movement operates the tool; and a
2	:	securing element for retaining the actuating member
3	•	in a first position until released by virtue of the
4		first piston reaching the final position, whereby the
5		actuating member moves to a second position and
6		operates the tool.
7		
8	13.	An actuating mechanism as claimed in Claim 12 wherein
9		the first and second pistons include substantially
LO	•	conical drive faces with apexes directed towards the
L1		applied pressure.
L2		
13	14.	An actuating mechanism as claimed in Claim 12 or
14	-	Claim 13 wherein the damping element is a fluid
15		metering device.
16		
17	15.	An actuating mechanism as claimed in Claim 14 wherein
18	• •	the fluid metering device comprises a fluid filled
19		chamber through which the first piston passes and a
20	•	portion of the first piston includes a restrictor to
21		regulate fluid flow between upper and lower
22	-	compartments of the chamber.
23 .		
24	16	. An actuating mechanism as claimed in Claim 15 whereir
25		a pressure balance piston is located in the chamber,
26		around the first piston so as to control the size of
27		the chamber in order to compensate for thermal
28	• • •	effects and pressure differences between inside and
29	·	outside the chamber.
30		
31	17	. An actuating mechanism as claimed in any one of
32		Claims 12 to 16 wherein the retaining element is a
33		spring.

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1	18.	An actuating mechanism as claimed in Claim 17 wherein
2	•	retaining element is a collet.
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4	19.	An actuating mechanism as claimed in any one of
5		Claims 12 to 18 wherein the locking element is a
6		sleeve such that the retaining element and the
7		locking element engage to control movement of the
8		pistons.
9	* •	
LO	20.	An actuating mechanism as claimed in any one of
L1		Claims 12 to 19 wherein the actuating member is a
12		sleeve and the securing element is one or more
13		locking keys which engage with the sleeve.
14		
15	21.	A method of controlling fluid flow in a well bore,
16		the method comprising the steps:
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18	•	(a) locating a plug in a well bore, the plug
19		including an actuating mechanism to operate the
20		plug;
21		(b) increasing pressure from a surface of the well
22		bore to within a predetermined range; and
23		(c) keeping the pressure within the predetermined
24		range over sufficient time to cause the actuating
25		mechanism to move and open the plug.
26		
27	22	. A method of controlling fluid flow in a well bore as
28		claimed in Claim 21 wherein the plug is as claimed in
29		any one of Claims 1 to 11.
30		
31	23	. A method of controlling fluid flow in a well bore as
32		claimed in Claim 21 or Claim 22 wherein the method

1	includes the	he step of	applying	pressure	above	the
2	predetermin	ned range.				

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24. A method of controlling fluid flow in a well bore as claimed in any one of Claims 21 to 23 wherein the method includes the step of locking the plug in a closed position in the event that the pressure exceeds the predetermined range.

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10 25. A method of controlling fluid flow in a well bore as
11 claimed in any one of Claims 21 to 24 wherein the
12 method includes the step of performing a pressure
13 test above the plug.

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15 26. A method of controlling fluid flow in a well bore as
16 claimed in any one of Claims 21 to 25 wherein the
17 method includes the step of bringing the pressure
18 back down to below the predetermined range to then
19 perform steps (b) and (c) to open the plug.